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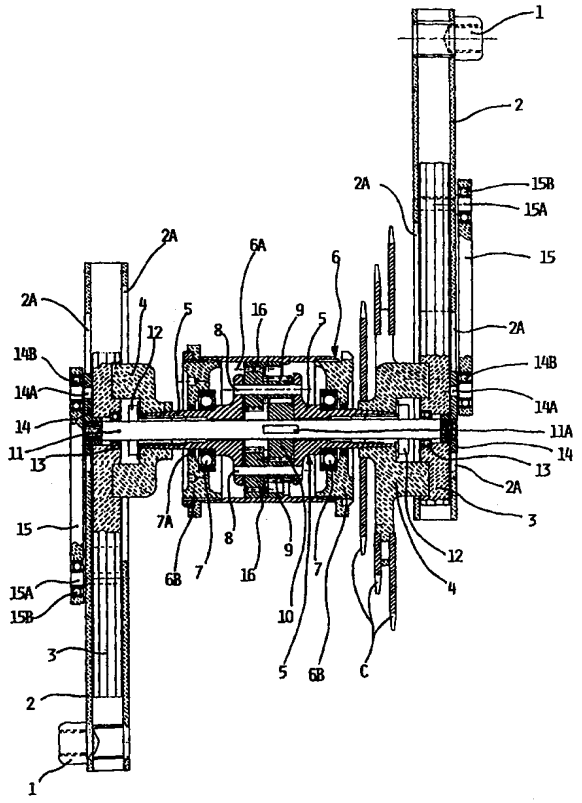
**(54) Title:** DEVICE AND METHOD FOR VARYING THE LENGTH OF PEDAL CRANKS, PARTICULARLY FOR BICYCLES

**(57) Abstract**

A device is described, for varying with continuity the length of arms (2, 3) of pedal cranks (1, 2, 3), particularly for bicycles, the arm of each pedal crank comprising a movable part (2), on which the pedal (1) is fastened, and a fixed part (3) rigidly connected to a rotary body (5) passing through a fixed container (6), said movable part (2) being guided to slide with respect to the fixed part (3) through a linkage (14–15) actuated by a shaft (11), which rotates coaxially within the rotary body (5), where means (9) are provided between said rotary body (5), said container (6) and said shaft (11) to transfer the rotation of the rotary body (5) to the shaft (11), so that the latter rotates around its own axis at a speed being different from the rotation of the rotary body (5), in particular at a double speed. According to the invention, means are provided for distributing or sharing of the mechanical stress generated by the rotation of said rotary body (9) on said shaft (11).



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# DEVICE AND METHOD FOR VARYING THE LENGTH OF PEDAL CRANKS, PARTICULARLY FOR BICYCLES.

## DESCRIPTION

The present invention relates to a device and a method for continuously varying the length of arms of pedals levers or cranks, particularly of bicycles.

Devices of the above type are already known and employed in the field of pedal vehicles, especially in the bicycles field, with the purpose of obtaining an extension of the pedal crank, i.e. the arm carrying each pedal, when starting its down stroke during cycling: as a result, a longer thrust arm will be available, right at the moment when the highest effort for pushing on the pedal is required.

A device of the above type is disclosed in the international patent application WO 94/26581, which can be consulted for further details.

In the device described therein each pedal crank comprises an external part on which the pedal is fastened, and an internal part rigidly connected to a revolving body or hub, passing through a fixed sleeve.

The external part of the pedal crank is guided to slide on its relevant internal part by a levers system actuated by a shaft, which revolves coaxially within the hub; means are provided between the hub, the sleeve and the shaft to transfer the hub rotation to the shaft for the latter to rotate around its own axis at a different speed with respect to the hub rotation.

According to the solution described in WO 94/26581, said means are obtained through a gearing system consisting of:

- a first gear rigidly connected to the shaft;
- a second and third gears, rigidly coupled between them along one same rotating axis and eccentrically assembled in the hub with respect to the rotating axis of the latter;
- an internally toothed crown wheel, rigidly connected to the sleeve.

The second gear engages the first gear while the third gear engages the toothed crown wheel, where the numerical ratio of the teeth between the various gears and the toothed crown wheel is such that the first gear can rotate around its own axis at a speed twice the rotation of the hub associated with the pedal crank.

According to the solution disclosed in WO 94/26581, the push on a pedal generates a rotary motion of the pedal crank and consequently of its internal and external parts; since the

internal part is connected to the hub, also the latter is forced to perform an identical rotation. Thus, the second gear, being engaged in the toothed crown wheel integral with the sleeve, will rotate around its own axis and also entrain the third gear with the same rotation; in this way, a rotation of the first gear is also obtained which, being keyed to the shaft, will force the latter to rotate; consequently, shaft rotation will cause a motion of the levers system associated to the pedal crank, which controls sliding of its external part on the internal part, so that during the highest effort of the push on a pedal, i.e. when the pedal is just starting its down stroke, the external part of the pedal crank will be extended to a maximum extent on its internal part, i.e. the crank reaches its maximum length.

Thus, as said, a device is provided, through which extensible pedal cranks or pedal levers can be obtained, with the purpose of an easier thrust.

The main purpose of WO 94/26581 consisted in solving the typical dimensional drawbacks of the previously known device and, in fact, some significant advantages in this direction can be obtained with the solution contained in the above cited document.

However, the present invention is based on the acknowledgement that the solution described in WO 94/26581 requires considerable overall dimensions and weight for a pedal vehicle, and that it would be desirable to further reduce them, especially in the field of sport and racing bicycles, where such requirements are particularly felt.

Moreover, the device described in WO 94/26581 has some reliability issues concerning some of its components, which especially under particular conditions of stress have a negative effect on the entire device life due to their manufacture and assembly method. A drawback associated with the previous problem is due to the fact that some movable components of WO 94/26581, for inherent stress reasons, have to be equipped with STRISCIAMENTO support means, which are subject to a fast wear and have a low efficiency; additionally, such STRISCIAMENTO support means are exposed to pollution from the environment outside.

The present invention has the aim of avoiding such drawbacks related to the known state of the art, as they will become more apparent in the following of the present description, and within this general frame, it is the object of the present invention to provide a device having an improved structure, a reduced size, weight and costs with respect to the solution disclosed by WO 94/26581, as well as a higher efficiency and reliability.

In order to achieve such aims, the object of the present invention are a device and a method

for varying the length of pedal levers of pedal cranks, particularly of bicycles, having the features of the annexed claims, which form an integral part of the present description.

Further aims, features and advantages of the present invention will become apparent from the following detailed description and the annexed drawings, which are supplied by way of non limiting example, wherein:

- Fig. 1 shows a sectional view of the device according to the present invention;
- Fig. 2 shows a first enlargement of a portion of the section shown in Fig. 1, for a better understanding of the representation ;
- Fig. 3 shows a second enlargement of a portion of the section shown in Fig. 1, for better understanding of the representation.

Referring especially to Fig. 1, reference 1 indicates two bushings wherein the pedals, omitted for simplicity's sake, as provided by the pedal crank according to the present invention are fastened.

Each bushing 1 is integral with a respective tubular element 2, which is apt to slide on an internal element 3; thus, the assembly of each element 2 and 3 represents the actuation arm of each pedal or pedal crank, the element 2 representing the external part and the element 3 the internal part; reference 2A indicates some slits on the opposite surfaces of the external parts 2, apt to allow their motion without interfering with other elements of the device, which will be described in the following (4, 10, 14).

It should be appreciated that, in the specific case shown in Fig. 1, the pedal crank on the right side is represented in a condition where its external part 2 is at its utmost extension on its relevant internal part 3 to which, conversely, a full backing of the external part 2 of the pedal crank on the left side is matching on its relevant internal part 3.

Each internal part 2 is connected through known means, such as brackets 4, to the two ends of a hub or rotary body, indicated with 5 as a whole, which is mounted through a sleeve or housing body 6.

The sleeve 6 comprises a hollow tubular portion 6A, on whose two ends covers 6B are fastened with means known as such; each of said covers 6B comprise a central opening, in correspondence of which a suitable bearing 7, of the rolling or ball type, so that the ends of the hub 5 may exit from the sleeve 6 and let the hub to rotate exactly.

Sealing elements 7A are also present in correspondence of the central openings of the covers 6B which in the figures operates on the hub 5; said sealing elements may have

known configurations differing from the one illustrated by way of example and in particular could be integrated directly in the bearings 7. As shown in Figs. 2 and 3, the hub 5 consists of two elements substantially similar, indicated with 5A and 5B, having substantially a T-section and consequently each one with an internally hollow tubular part 5', wherefrom derives a flanged part 5'', having for example a disc shape; the two flanged elements are connected in a known way, such as through bolts, pins and/or spacers (not shown), so as to form a rigid body defining a central cavity, between the two flanged parts 5'' mentioned above. Each flanged parts 5'' has at least two holes to house the ends of two supporting pins 8.

Reference 9 indicates two satellite gears as a whole, which are substantially equal, being mounted in the middle cavity of the hub 5 and each having a central hole for receiving the pins 8; such supporting pins 8 therefore represent the rotary axis of the satellite gears 9.

As shown in Figs. 2 and 3, each satellite gear comprises a first toothed wheel 9A and a second toothed wheel 9B, integral to each other or rigidly coupled, the first one having a greater diameter than the second one. The second toothed wheels 9B are both engaged to one same toothed wheel 10, which is located within the hub 5 and is rigidly coupled to a shaft 11, for example through a key 11A.

As it can be noticed, the shaft 11 is so inserted in the cavity of the hub 5 to exit from its both ends; protection bushings are provided on such ends of the hub 5, the shaft 11 passing through them without any interference.

The ends of the shaft 11 are then passing through the internal parts 3 of the pedal cranks, where they are supported by suitable means consisting of rolling bearings 13; on the ends of the shaft 11 two first levers 14 are rigidly coupled, in correspondence with slits 2A of each external part 2 of the pedal cranks.

Each one of the two first levers 14 is pivoted through a pin 14A and a rolling bearing 14B on one end of a respective second lever 15; the other end of each one of the second levers 15 is pivoted through a pin 15A and a rolling bearing 15B on the external part 2 of the pedal cranks.

As it will be noticed, therefore, the connection between the external part 2 of each pedal crank and one end of the shaft 11 is obtained through a linkage of the connecting rod - crankshaft type, the crankshaft being represented by the lever 14 and the connecting rod by the lever 15.

In the figures, reference 16 indicates a crown wheel being internally toothed, which is assembled within the sleeve 6 and is in particular either integral or made integral with the tubular portion 6A of the sleeve itself.

As it can be seen, particularly in Fig. 3, the assembly of the various components provides for both first toothed wheels 9A of each satellite gear 9 to be engaged with the toothed wheel 10 integral with the shaft 11.

It should be noticed that the numerical ratio of the teeth of the satellite gears 9, the toothed wheel 10 and the toothed crown wheel 16 is such that the wheel 10 rotates around its own axis (consisting of the shaft 11) at a speed twice the rotation speed of the hub 5 to which each pedal crank is associated with; in fact, since the pedals perform a complete rotation, the linkage has to perform a complete fore-and-backward motion.

Finally, reference C indicates standard crowns fastened in a known way to one of the brackets 4 whose purpose is to transmit through a standard chain (not shown) the motion generated by the pedals rotation to the rear wheel of the vehicle whereon the device according to the present invention is assembled.

It will be appreciated, in this connection, that the device according to the present invention is apt for assembly on pedal vehicles, such as bicycles, where pedal cranks usually depart from; therefore, in this frame the tubular part 6A may consist of the usual sleeve pertaining to the frame of bicycles fitted with conventional pedal levers.

The device described above operates as follows.

As usual, also in the case of the present invention the pedal stroke produces a rotary motion for each one of the two pedal cranks.

In the specific case, the thrust exerted on the pedals and transferred by the user's feet to the external parts 2 is converted into a rotary motion of the latter and, consequently, also to the internal parts 3 of the pedal cranks. Since the internal parts 3 are rigidly coupled with the hub 5 through the brackets 4, also the hub 5 is pushed to rotate, thus determining a rotary motion also of the satellite gears 9.

Both the first toothed wheels 9A of the satellite gears 9 are engaged in the toothed crown wheel 16, which is integral with the sleeve 6, so that they are led to rotate around the respective axis 8 also entraining the second toothed wheels 9B in the same planetary rotation; this also determines the rotation of the toothed wheel 10, whereon both the second toothed wheels 9B are engaged.

The toothed wheel 10 being keyed on the shaft 11, also the latter will be forced to rotate, with a consequent motion of the linkage consisting of levers 14 and 15, which is apt to transfer the rotation of the shaft 11 to the external parts 3 of the pedal cranks.

Such a linkage is conceived, in a known way, to control the sliding of the external parts 2 on the internal parts 3, so that at the time the highest efforts is exerted on a pedal, i.e. when it starts its down stroke, the relevant external part 3 will be extended to a maximum extent on its relevant internal part 2, i.e. the crank 2, 3 is at its utmost length (situation of the pedal on the right side of Fig. 1); in such a moment, the other pedal will conversely be in a specular position, i.e. nearly at the end of its down stroke, and the linkage consisting of levers 14 and 15 will cause the relevant external part 3 to reach its utmost backward position on its relevant internal part 2, i.e. the crank 2, 3 is at its shortest length (situation of the pedal on the left side of Fig. 1). It should be appreciated, in this connection, that the motion of external parts 2 with respect to internal parts 3 and the motion of the levers 14 is permitted by virtue of the slots 2A.

Therefore, as it can be seen, a device is obtained which allows for having pedal cranks of variable length, right with the purpose of facilitating the thrust at the time of the highest effort, where the progressive and continuous action of length variation of the pedal cranks ensures the pedal stroke roundness.

The above explained, it is clear how the general operation of the device according to the present invention occurs in a similar way with respect to WO 94/26581.

However, in spite of this apparent similarity, the device according to the present invention allows for obtaining substantial advantages with respect to the solution described in the above document, which are not suggested therein.

The basic idea of WO 94/26581, in fact, was to provide a device with a minimized number of manufacturing components, right with the aim of reaching the expected reduction of its overall dimensions and total weight. Therefore, within this frame, the device according to WO 94/26581 has been manufactured providing a sole satellite gear, wherein the housing hub of such a satellite gear should consist of one sole piece, as it is obvious from its description.

According to the present invention, on the contrary, it was surprisingly found that provision of additional elements, in particular at least of a further satellite gear entails substantial advantages; the same applies to the idea of providing the housing hub for the satellite gears

consisting of several parts.

A first significant effect according to the present invention, in fact, is a substantial reduction of the stresses exerted on the teeth of the gearing system, by virtue of the fact that said stresses are distributed over a larger number of satellite gears; in this way, the teeth of the satellite gears 9A-9B according to the embodiment of the invention described above by way of example are able to support stresses which are reduced by more than a half with respect to those supported by the teeth of the sole satellite gear provided in WO 94/26581.

Since the satellite gears provided by the present invention have to support minor stresses, they can also have smaller dimensions with respect to the cited prior art; as a result, also the toothed wheel 10 keyed to the shaft 11 and the toothed crown wheel 16 integral with the sleeve 6 will have smaller dimensions with respect to the ones provided for in WO 94/26581.

To this effect, it will be appreciated that a dimensional reduction of the above gearing system according to the present invention, which can be obtained through two or more satellite gears, may be around 30% against the solution provided in WO 94/26581.

Another significant technical effect according to the solution of the present invention is the symmetrical configuration of the forces transferred from the hub 5 to the shaft 11, which allow the suppression of the bending moments both on the shaft 11 and the hub 5.

In the solution described in WO 94/26581, in fact, the provision of a single satellite gear determines a force discharge from the hub to the shaft in one sole direction; since such a force is not compensated by an analogous force in the opposite direction, flexures of the shaft 11 will be determined, in the fastening area of the toothed crown wheel 10; similarly, such a non-compensated force discharge will also determine bending moments in the hub itself; with a negative result on the device performance and its useful life.

According to the present invention such a specific problem is removed through the provision of at least two satellite gears. According to the present solution, in fact, the force discharged from a satellite gear 9 to the toothed crown wheel 10 and then to the shaft 11, is compensated on the opposite side by the analogous force discharged from the other satellite gear 9.

In other words, the fact that the two satellite gears 9 are arranged symmetrically with respect to the shaft 11, prevents the drawback mentioned for the known state of the art, and such a symmetrical forces arrangement according to the present invention allows for the

suppression of all bending moments both on the shaft 11 and the hub 5.

In this way, also a further significant technical result is reached: the removal of the above bending moments allows, according to the invention, the supporting means of the shaft 11 to be spaced apart from each other. Such means, in the instance of WO 94/26581, must be forcedly arranged on the two ends of the hub, in adequate housings provided by it, consist of bronze bushings due to stress reasons.

In view of the absence of bending moments, as obtained through the teachings contained in the present invention, the supporting means 13 of the shaft 11 can on the contrary be spaced apart from each other, so that consequently and consequently be arranged outside the hub; in particular they can be fastened directly on the fixed part 3 of the pedal cranks; advantageously, said means consist of rolling bearings 13.

Since the supporting means 13 of the shaft are not housed inside the hub 5, the dimensions of the latter and consequently of the main body 6 of the device according to the present invention can be further reduced; the fact that said supporting means 13 consist of rolling bearings allows consistent friction reductions with respect to the above known solution.

Thus, from the above it is clear how according to the present invention it is possible to miniaturize, i.e. to make the core of the device smaller, and also reduce its total weight, while allowing at the same time an optimal distribution or splitting of the mechanical stress generated by the rotation of the hub 5 on the shaft 11, and a higher general performance.

The improved technical result provided by the present invention is further enhanced through the manufacturing method of the hub 5.

As said, the hub provided in WO 94/26581 is manufactured in one piece having an eccentric part with two shoulders for housing and fastening the sole satellite gear provided; such a configuration matches in fact the basic idea of WO 94/26581, tending to reduce the number of components and possibly increase the sturdiness of the ones provided.

However, also from this standpoint some drawbacks can be noticed in the known solution. In fact, manufacture of the hub in one piece according to the known state of the art necessitates its casting; the casting is a process limiting the number of materials which can be used, or a process requiring costly chips removal operations.

According to the present invention, on the contrary, manufacture of the hub 5 is proposed in several parts, namely parts 5A and 5B, which are fastened together in a known way through bolts, spacers, etc.

Splitting the hub 5 at least in two distinct parts possibly also allows the use of a shaft 11 with an enlarged diameter in its middle area, where the toothed wheel 10 is fastened. Such an enlargement of the shaft 11 considerably improves its torsional resistance and stiffness, with respect to the known solution mentioned above.

In fact, in the instance of WO 94/26581, since the hub is manufactured in one piece, the provision of a shaft having a main area with an enlarged diameter is prevented: in fact, such a shaft cannot be inserted in the hub through one of its ends as described by the prior art, save to provide a throughway with a considerable diameter, i.e. with obviously negative consequences in terms of size increase and stability.

Hub manufacture in several parts according to the present invention therefore determines the following important advantages:

- the pieces forming the hub according to the present invention can be obtained at industrial level in a much simpler and faster way, as they may consist of simple mechanical elements, whose relevant materials can be freely chosen and processed in automated machines; said materials can be advantageously selected between light materials with a high mechanical resistance; as a result, the piece will have a lower manufacturing cost but a more efficient structure at the same time;
- since the hub is substantially manufactured in two parts, which are joined together through simple spacers and bolts, a smaller quantity of material will be required with respect to the known state of the art (in WO 94/26581, in fact, the spacer function is obtained using a considerable amount of material forming the hub);
- the special configuration in separate parts allows the association of the hub 5 with a shaft 11 having a diameter enlargement in its middle area, with obvious advantages from the viewpoint of torsional resistance and part rigidity.

Consequently, also in virtue of the optimal splitting of the stress on the various satellite gears as described above, both the cracking and wear risks for the various elements are considerably reduced in spite of their smaller dimensions with respect to the known state of the art.

From the above description the features of the device and of the method for varying the length of pedal cranks, particularly of bicycles, according to the present invention are clear.

In particular, a device for varying the length of pedal cranks, particularly of bicycles, has been described, wherein each pedal crank comprises an external movable part 2, on which

the pedal is fastened, and an internal fixed part 3, rigidly connected to a hub or rotary body 5 and passing through a container or fixed sleeve 6; the movable part is guided to slide with respect to the fixed part 3 through a linkage 14-15 actuated by a shaft 11, which rotates coaxially within the hub 5, where transmission organs 9, 10, 16 are provided between the hub 5, the sleeve 6 and the shaft 11 to transfer the rotation of the hub 5 to the shaft 11, so that the latter rotates around its own axis at a speed being different from the rotation of the rotary body, in particular a double speed.

According to the present invention, means are advantageously provided to distribute or share the mechanical stress produced by the hub rotation 5 on the shaft 11; in particular, said means 9 are apt to symmetrically distribute, with respect to said shaft 11, the mechanical stress discharged by the hub 5 to the shaft 11 itself, the symmetrical distribution of such stress allowing for suppressing bending moments of the shaft 11 and/or the hub 5.

The above means preferably comprise a plurality of first organs 9 associated to the hub 5, each of them being apt to directly transfer its own motion to a similar second movable organ 10 associated to the shaft 11.

The first movable elements 9 are mounted in a planetary and/or symmetrical way with respect to the rotation axis of the hub 5 and comprise at least two or three satellite gears 9, engaged between a toothed wheel 10 rigidly coupled to the shaft 11 and an internally toothed crown wheel 16 integral with the sleeve 6.

According to other important features of the present invention:

- the hub 5 is realized in at least in two separate parts 5A-5B coupled together;
- the shaft 11 has a diameter enlargement in its middle area, whereto the second movable organ 10 is fastened;
- the supporting means of the shaft 11 are located outside the hub 5, in particular they are fastened to the fixed parts 3 of the pedal cranks.

From the above description also the advantages of the device and of the method for varying the crank length of pedal cranks, particularly for bicycles, according to the present invention are clear. Specifically:

- the device described above allows for an improved distribution of the mechanical stress generated by the rotation of the hub 5 on the shaft 11, and consequently a reduction of the stresses on the gears 9, 10, 16, right in virtue of a plurality of satellite gears;
- the splitting of the stresses on several satellite gears 9 allows for manufacturing the latter

with reduced dimensions, and consequently with also a smaller dimensions of the further gears 10 and 16 associated with them; as a result, a total reduction of the overall dimensions and weight of the device as a whole is obtained;

- the provision of several satellite gears allows for a symmetrical arrangement of the stressed being transferred by the satellite gears 9 to the toothed wheel 10, thus avoiding bending moments both on the shaft 11 and the hub 5; moreover, the relevant supporting means can be moved away from the hub 5, and they may then consist of rolling bearings 13 housed directly on the pedal cranks, with a further possible dimensional reduction of the main body of the device and sensible friction reductions;
- the provision of a hub 5 consisting of several parts 5A, 5B, 8 allows a low-cost manufacturing process, a reduction of the material required (i.e. a further weight reduction with respect to the known state of the art), the possible use of a centrally reinforced shaft 11, with improved torsional resistance and stiffness.
- in general, all movable organs of the device can be supported by rolling bearings with a considerable friction reduction.

From the above, it is clear how the present invention allows to perfectly reach its predetermined purposes, i.e. to provide a device whose structure, overall dimensions, weight and cost are improved and have a higher reliability with respect to the known solution of WO 94/26581.

The whole, as mentioned above, is surprisingly achieved increasing the number of components of the device instead of reducing it, as suggested by the known state of the art.

It is obvious that many changes are possible for the man skilled in the art to the device and the method for varying the length of pedal cranks, particularly for bicycles, described above by way of example, without departing from the novelty spirit of the innovative idea, and it is also clear that in practical actuation of the invention the components may differ in form and size from the ones described and be replaced with technical equivalent elements.

A first possible variant of the present invention may concern the number of satellite gears provided. In fact, the advantages mentioned above for the present invention may be further enhanced with the provision of a larger number of satellite gears.

Practical tests have already proved, in fact, that the objects of the present invention in terms of higher reliability and reduced overall dimensions and weight can be achieved with respect to the known state of the art using three satellite gears of the type previously indicated with

9, which operates on a single internally toothed crown wheel 16 and a single gear 10 keyed to the shaft 11, respectively.

A further variant of the invention concerns the provision of suitable protection means, being mounted on the pedal cranks, in correspondence with the areas where the levers system consisting of the connecting rods 14-15 operates.

The provision of such further means, which is advantageously allowed in virtue of a substantial reduction of the overall dimensions and above all of the weight of the device, plays a particular role both in terms of aerodynamics and protection against dust, mud, water and soil in general.

In the instance of racing and sport bicycles, such protection means may consist of shells made of shock-proof light material, such as thermoplastic resin, to be snap- fitted on the external parts 2 of the pedal cranks, to enhance aerodynamics of the latter and cover the area wherein the connecting rods 14-15 are working.

In the instance of cycle-cross bicycles or bicycles known as ''mountain bike'', such protection means made of shock-proof light material may consist, on the contrary, of pairs of screw-fastened half-shell, to better cover the outside parts of the device. In this instance, one of said half-shells would be assembled on the part where the brackets 4 are located and the other one assembled on the opposite side of the external parts 2 of the pedal cranks, i.e. the area where the connecting rods 14-15 are working.

The above figures show the possibility of providing rolling bearings 7 with integrated sealing means 7A; anyway, it is obvious that all rolling support means provided by the device according to the present invention can be fitted with protection means against external agents, i.e. watertight sealing elements.

Another possible variant, whose object is to further reduce friction, is to provide suitable rolling support means also for the pins 8 or the satellite gears 9; such means could advantageously be configured as rollers shells and be interposed between the pins 8 and the flanges 5'', in the relevant holes foreseen on the latter, or between the pins 8 and the satellite gears 9.

## CLAIMS

1. Device for varying the length of arms (2,3) of pedal cranks (1,2,3), particularly for bicycles, the arm of each pedal crank comprising a movable part (2) on which the pedal (1) is fastened, and a fixed part (3) rigidly connected to a rotary body (5) passing through a fixed container (6); the movable part (2) being guided to slide with respect to the fixed part (3) through a linkage (14-15) actuated by a shaft (11) which can rotate coaxially within the rotary body (5), where transmission organs (9,10,16) are provided between said rotary body (5), said container (6) and said shaft (11) to transfer the rotation of the rotary body (5) to the shaft (11), so that the latter rotates around its axis at a speed being different from the rotation of the rotary body (5), in particular at a double speed, characterized in that means (9) are provided for distributing or sharing the mechanical stress generated by the rotation of said rotary body (5) on said shaft (11).

2. Device, according to claim 1, characterized in that said means (9) are apt to distribute in a symmetrical way with respect to said shaft (11), the mechanical stress discharged by said rotary body (5) to said shaft (11), the symmetrical distribution of said stress allowing the suppression of bending moments of said shaft (11) and/or of said rotary body (5).

3. Device, according to claim 1 or 2, characterized in that said means (9) comprise a plurality of first movable organs (9) associated to said rotary body (5), each one of them being apt to transfer its motion directly to a same second movable organ (10) associated to said shaft (11).

4. Device, according to claim 3, characterized in that said first movable organs (9) are mounted in a planetary way with respect to the rotating axis of said rotary body (5).

5. Device, according to claim 3, characterized in that said first movable organs (9) are symmetrically arranged with respect to said shaft (11).

6. Device, according to claim 3 or 4, characterized in that said first movable organs (9) comprise at least two satellite gears (9) with respect to said shaft (11), which are substantially similar to each other.

7. Device, according to claim 6, characterized in that said first movable organs (9) comprise at least three satellite gears (9) with respect to said shaft (11), which are substantially similar to each other.

8. Device, according to claim 6 or 7, characterized in that said second movable organ is a toothed wheel (10) rigidly coupled to said shaft (11), to which said satellite gears (9) are

engaged.

9. Device, according to claim 6 or 7, characterized in that each of said satellite gears (9) comprises a first toothed wheel (9A) and a second toothed wheel (9B) rigidly coupled between them, the first one having a larger diameter than the second one.

10. Device, according to claims 8 and 9, characterized in that the second toothed wheels (9A) of each satellite gear (9) are engaged to the toothed wheel (10) coupled to said shaft.

11. Device, according to claim 6 or 7, characterized in that said satellite gears (9) are engaged to one same gear (16) being integral with said fixed container (6).

12. Device, according to claim 11, characterized in that said gear integral with said fixed container (6) is a crown wheel being internally toothed (16).

13. Device, according to claims 9 and 11 or 12, characterized in that the first toothed wheels (9B) of each satellite gear (9) are engaged with said gear (16) being integral with said fixed container (6).

14. Device, according to claim 1, characterized in that said rotary body (5) is manufactured in at least two distinct parts (5A, 5B) mutually coupled, in particular through bolts.

15. Device, according to claims 3 and 14, characterized in that said two distinct parts (5A, 5B) have respective holes for housing the ends of pins (8) for the fastening and/or the rotation of said first movable organs (9) to said rotary body (5), rolling support means being in particular provided for said pins (8) and/or said first movable organs (9).

16. Device, according to claim 14, characterized in that said shaft (11) has a diameter enlargement in its middle area, which results in being located between said two distinct parts (5A, 5B), in said middle area of said shaft (11) being in particular fixed said second movable organ (10).

17. Device, according to claim 2, characterized in that the support means of said shaft (11) are located externally with respect to said rotary body (5), and in particular are fastened on said fixed part (3).

18. Device, according at least to one of the previous claims, characterized in that said linkage comprises at least two levers (14,15), which are mutually coupled to form a connecting rod - crank system, the lever representing the crank (14) being associated to said shaft (11) and the lever representing the connecting rod (15) being associated to one of said movable organs (2).

19. Device, according to at least one of the previous claims, characterized in that the

support means (13) of said shaft (11), and/or the support means (7) of said rotary body (5), and/or the coupling means (14B) of said first lever (14) to said second lever (15), and/or the coupling means (15B) of said second lever (15) to said movable element (2) are of the rolling type, such as ball bearings.

20. Device, according to claim 19, characterized in that said support means (7,13) and/or coupling means (14B,15B) have protection means against external agents, said bearings having in particular watertight sealing elements.

21. Device, according to claim 1, characterized in that protection means are provided, which are associated to the arm (2, 3) of each pedal crank (1).

22. Device, according to claim 21, characterized in that said protection means comprise shells being snap-fitted to said movable parts (2) of the pedal cranks (1), which are apt to cover the area where said linkage (14, 15) operates.

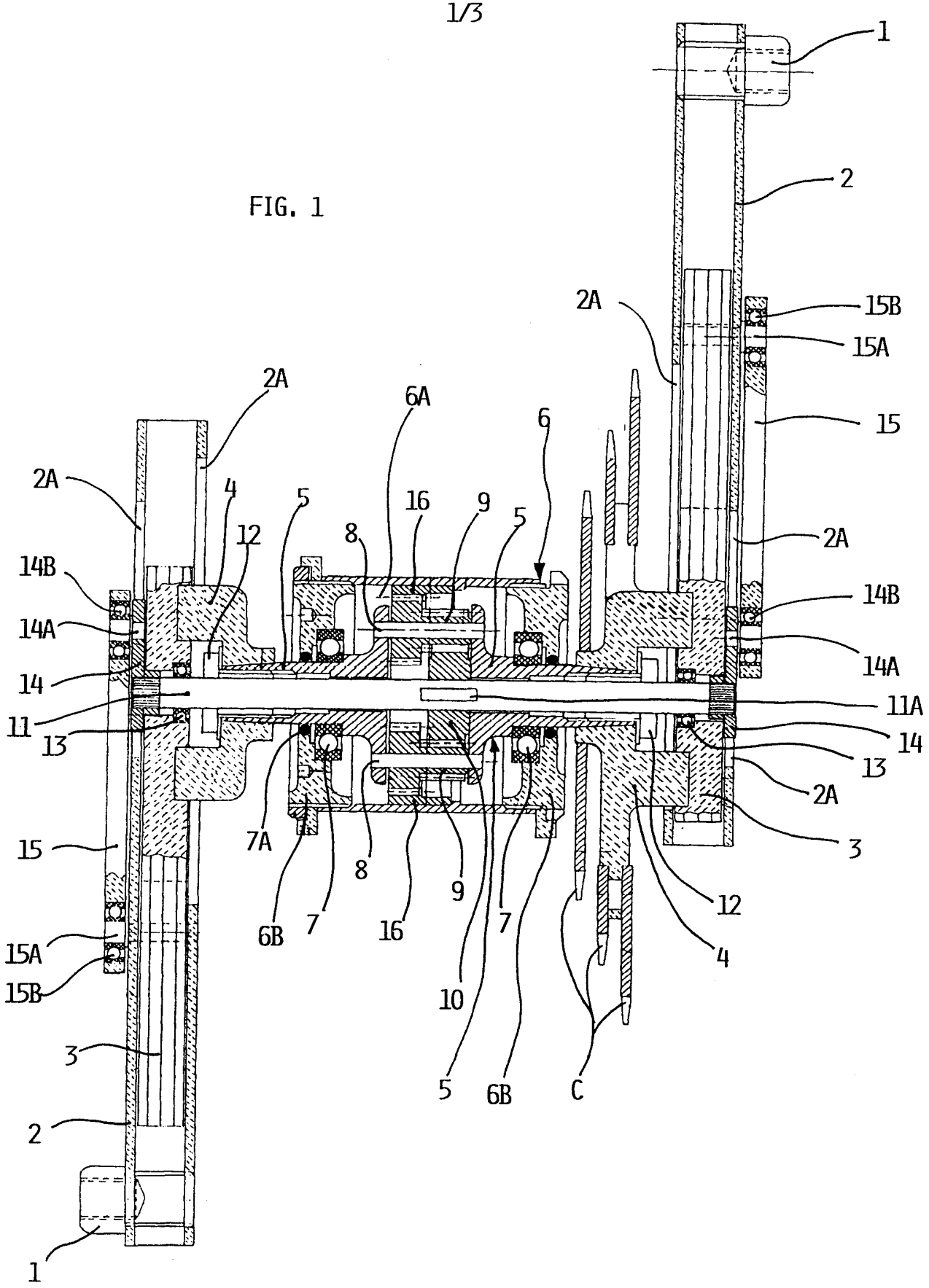
23. Device, according to claim 21 characterized in that said protection means comprise pairs of half-shells, which are mutually secured by means of screws.

24. Method for varying the length (2,3) of arms of pedal cranks (1,2,3), particularly for bicycles, the arm of each pedal crank comprising a movable part (2), on which the pedal (1) is fastened, and a fixed part (3) rigidly connected to a rotary body (5) passing through a fixed container (6), said movable part (2) being guided to slide with respect to the fixed part (3) through a linkage (14-15) actuated by a shaft (11), which rotates coaxially within the rotary body (5), where organs (9) are provided between said rotary body (5), said container (6) and said shaft (11) to transfer the rotation of the rotary body (5) to the shaft (11), so that the rotates around its axis at a speed being different from the rotation of the rotary body (5), in particular at a double speed, characterized by a distribution or splitting of the mechanical stress generated by the rotation of said rotary body (5) on said shaft (11).

25. Method, according to claim 24, characterized by a distribution in a symmetrical way with respect to said shaft (11) of the mechanical stress discharged by said rotary body (5) to said shaft (11), the symmetrical distribution of said stress allowing the suppression of bending moments of said shaft (11) and/or said rotary body (5).

26. Method, according to claim 24 or 25, characterized in that said distribution is obtained through a plurality of first movable organs (9) associated with said rotary body (5), each one of them being apt to transfer its own motion directly to one same second movable organ (10) associated to said shaft (11).

FIG. 1



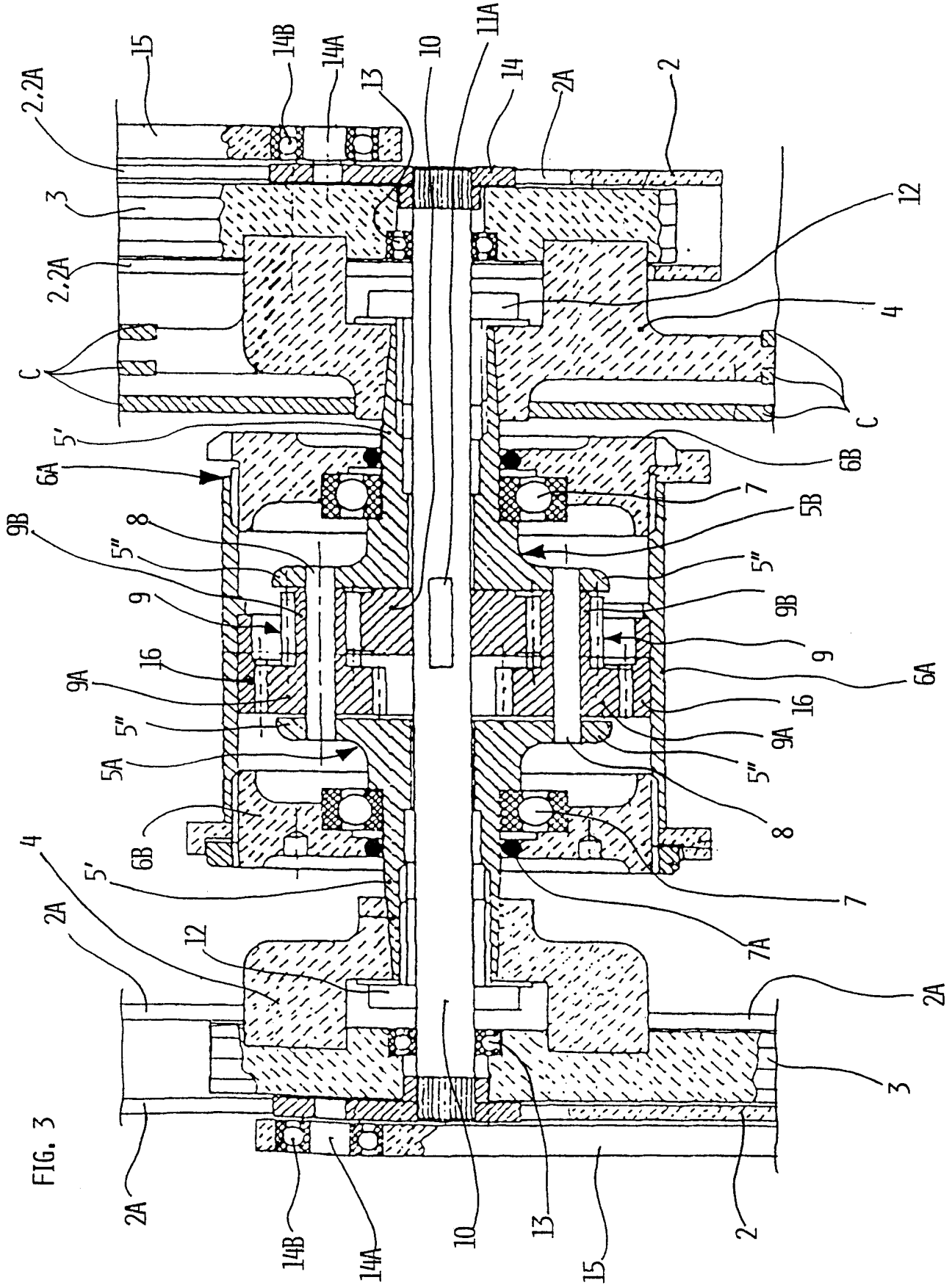
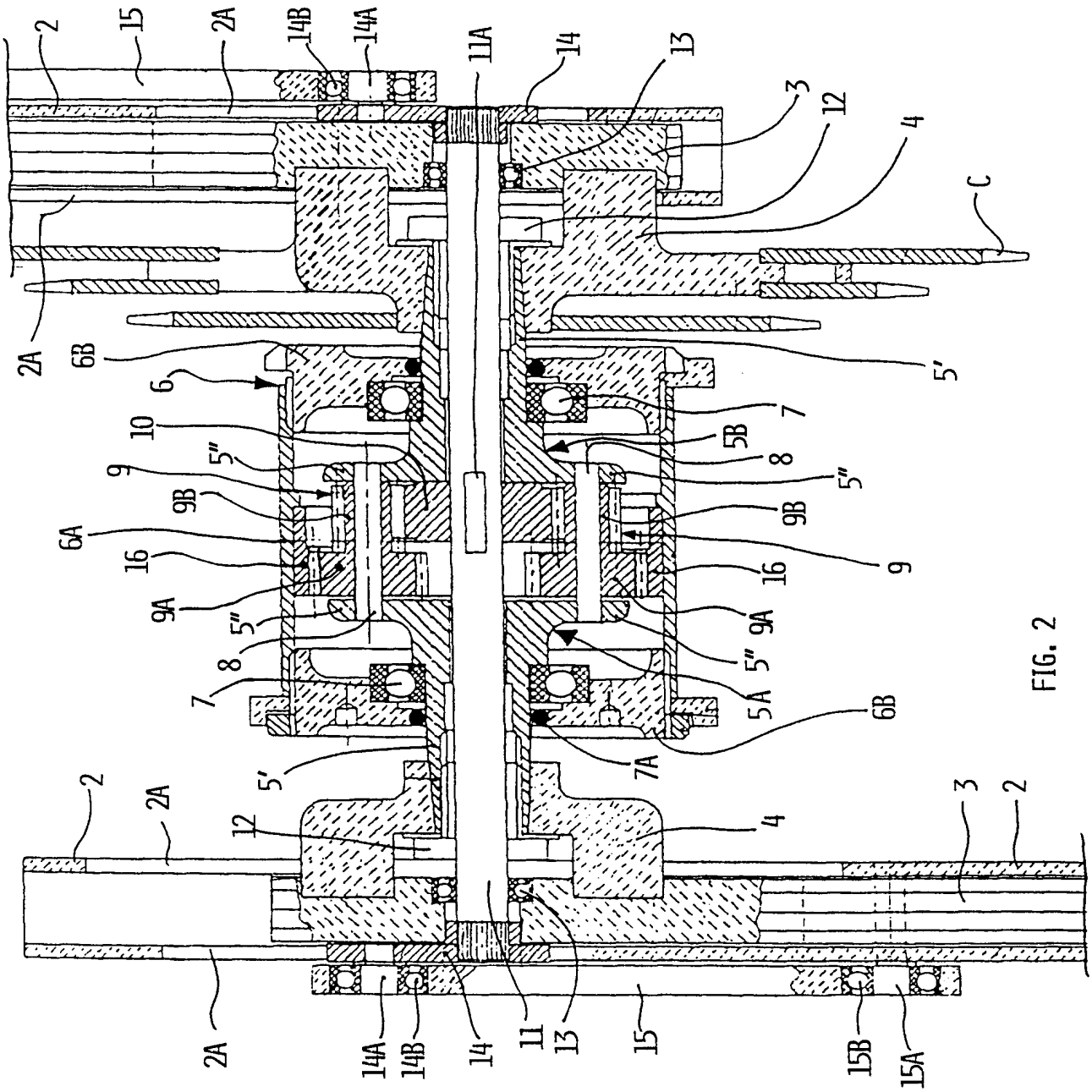



FIG. 3


2
15
2A
14B
14A
11A
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13
3
12
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C
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5"
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2
2A
12
4
3
2
2A
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14B
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15A

FIG. 2

# INTERNATIONAL SEARCH REPORT

Int tional Application No
PCT/IB 99/00414

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 6 B62M3/04 B62M11/14

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B62M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | WO 94 26581 A (GIUSTOZZI) 24 November 1994<br>cited in the application<br>see the whole document | 1-26 |
| Y | US 4 644 828 A (KOZAKAE) 24 February 1987<br>cited in the application<br>see abstract; figure 1 | 1-26 |

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 25 June 1999 | 02/07/1999 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Denicolai, G |

1

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Int[illegible]tional Application No
PCT/IB 99/00414

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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| | | DE 59407690 D | 04-03-1999 |
| | | EP 0650432 A | 03-05-1995 |
| | | JP 7509201 T | 12-10-1995 |
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| | | EP 0159855 A | 30-10-1985 |

**DERWENT-ACC-NO:** 1999-610607

**DERWENT-WEEK:** 200207



**TITLE:** Arm length adjustment tool for pedal crank of bicycle

**INVENTOR:** GIUSTOZZI I

**PATENT-ASSIGNEE:** DEMA SRL[DEMAN]

**PRIORITY-DATA:** 1998IT-TO0229 (March 16, 1998)

**PATENT-FAMILY:**

| PUB-NO | PUB-DATE | LANGUAGE |
|---|---|---|
| WO 9947410 A1 | September 23, 1999 | EN |
| AU 9932680 A | October 11, 1999 | EN |
| IT 1300744 B | May 23, 2000 | IT |

**DESIGNATED-STATES:** AL AM AT AU AZ BA BB BG BR BY CA CH CN CU CZ DE DK EE ES FI GB GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT UA UG US UZ VN YU ZW AT BE CH CY DE DK EA ES FI FR GB GH GM GR IE IT KE LS LU MC MW NL OA PT SD SE SL SZ UG ZW

**APPLICATION-DATA:**

| PUB-NO | APPL-DESCRIPTOR | APPL-NO | APPL-DATE |
|---|---|---|---|
| WO1999047410A1 | N/A | 1999WO-IB00414 | March 13, 1999 |
| IT 1300744B | N/A | 1998IT-TO0229 | March 16, 1998 |
| AU 9932680A | Based on | 1999AU-032680 | March 13, 1999 |

**INT-CL-CURRENT:**

| TYPE | IPC DATE |
|---|---|
| CIPS | B62M11/14 20060101 |
| CIPS | B62M3/04 20060101 |

**ABSTRACTED-PUB-NO:** WO 9947410 A1

**BASIC-ABSTRACT:**

NOVELTY - Two satellite gears (9) symmetrically set in a hub (5) meshes toothed wheel (10) on a shaft (11) penetrating the hub. Each end of the shaft connects a pedal-mounting movable cylinder (2) by two levers (14,15). The hub is stored in a sleeve (6). The gears mesh the crown wheel (16) in the sleeve together with the toothed wheel, hence transmitting the hub rotation to the shaft.

DESCRIPTION - When thrust by a user's foot acts on each pedal, the movable cylinder slides relative to

a fixed cylinder (3), generating linear motion transmitted as rotation to the shaft. The shaft rotates together with the toothed wheel and the hub. The engagement of the toothed and crown wheels and the satellite gears allow the extending length of the movable cylinder to be adjusted as well as minimize stresses generated by rotation of the shaft and the hub. An INDEPENDENT CLAIM is also included for a pedal crank arm length adjustment method.

USE - Continuously varying length of arms of pedal levers or cranks of bicycle.

ADVANTAGE - Achieves reduction of overall dimensions and weight of length adjustment tool, hence reducing its manufacturing cost. Ensures roundness of pedal stroke. Suppresses all bending moments acted on shaft due to symmetrical arrangement of satellite gears.

DESCRIPTION OF DRAWING(S) - The figure shows the sectional view of the pedal crank arm length adjustment tool.

Movable cylinder (2)

Fixed cylinder (3)

Hub (5)

Sleeve (6)

Satellite gears (9)

Toothed wheel (10)

Shaft (11)

Levers (14,15)

Crown wheel (16)

**CHOSEN-DRAWING:** Dwg.1/3

**TITLE-TERMS:** ARM LENGTH ADJUST TOOL PEDAL CRANK BICYCLE

**DERWENT-CLASS:** Q23

**SECONDARY-ACC-NO:**

**Non-CPI Secondary Accession Numbers:** 1999-449910